

OPTIMIZATION POSSIBILITIES IN CAD/CAM SYSTEMS

*Doc. Ing. Nadežda Čuboňová PhD., Ing. Miroslav Michalco,
University of Zilina, Department of Machining and Automation, SK-010 01 Zilina,
Slovak Republic, Phone: ++421 41 513 2810, ++421 41 513 2817
E-mail: nadezda.cubonova@fstroj.uniza.sk, miroslav.michalco@fstroj.uniza.sk*

1. INTRODUCTION

Process optimization is a necessary condition for good process solution of technology in CAD/CAM system. For example optimization appear from workpiece, which is gradually actualized, in consequence the next roughing operation is machining workpiece only there, where it is really necessary – elimination of ineffective moves and operations. Another optimization is optimization regarding to shape, proportions of tool and fixture or spindle, where the system is optimizing machining strategy regarding to undercutting or collision of above mentioned system with machined surface. Next is eliminating of machining surface, which is out of available machining space, regarding to tool length. Technological CAD/CAM system contains wide possibilities in definition of tool, fixtures or spindle, also other components of metal cutting machine (headstock, etc.). Except of tool and workpiece collision detection there are possibilities of collision detection as with other elements of machining scene so with other machine elements (table, fixtures, etc.). Important advantage of CAD/CAM systems are their technological functions, which detect residual material (unmachined surfaces in corners, regarding to tool and tip shape) and are able to machine this material with appropriate strategies. Another part of optimal solution is possibility of application of Spline interpolation, that leads especially in high speed cutting to essential gain: higher feed speeds (30–50%), higher accurate and quality of machined surface, that eliminates time-consuming manual workpiece finishing. Another positive is reduction of NC programs. Uniform tool motion without changes of acceleration in corner points of segment path positively affects total machine load, its lifetime and durability of cutting tool face. On the other side certain disadvantage of using Spline interpolation is almost impossible manual editing of NC program and its lower limpidity in relation to next tool motion direction.

2. OPTIMIZATION SOFTWARE

For optimization of technologic processes are used software applications that the way of realization is most often solved through additional modules. These modules helped in machining process for optimization of tool paths, cutting parameters, NC programs etc. For generation of real effective NC control system it is important to project cutting conditions with their optimization. For this kind of optimization it is appropriate to use computer aid, which allows beginning of optimization software. This software used mathematical methods for setting cutting conditions. In term of integration of optimization software into the CAM system we can present optimization software divide to three basic groups:

2.1 Independent optimization software

Their results are cutting conditions, which we need enter into NC program manually. Usually these are produced in one of the standard program language, like Turbo Pascal, Visual Basic, Delphi etc. For example, at STU in Bratislava, KOM MTF Trnava was produced independent optimization software OPTICUT, which serves for modifying NC data for CNC milling (specifically – spindle speed and cut feed) in the last machining phase, finishing. Application OPTICUT was designed in program language Visual Basic 6.0.

2.2 Collaborative optimization software

With using this software NC data produced in CAM system are analyzed first and then optimized. This software performs virtual simulation of machined workpiece that means it checks immediate cross section of removed sliver and within the interval of entered values of cut feeds returns optimal cut feed. NC machine then adapts to actual engagement and does not realize with constant cut feed. In places, where more of the material is machined, cut feed is decreased. In places where less of the material is machined, cut feed is increased. Some of the software from this group disposed with functions, which adapts spindle speed to optimized cut feed. Into this group of software belongs for example:

NCspeed (Formtec) - it is an software for optimization of CAM system output data. It simulates machining, checks the immediate sliver cross section and within the interval of entered values of cut feed (min., max.) and additive conditions, returns optimal cut feed into NC data taked from CAM. This software dispose with functions for regulating of spindle speed based on optimized cut feed. NCspeed works with finished NC data, produced in optional CAM system.

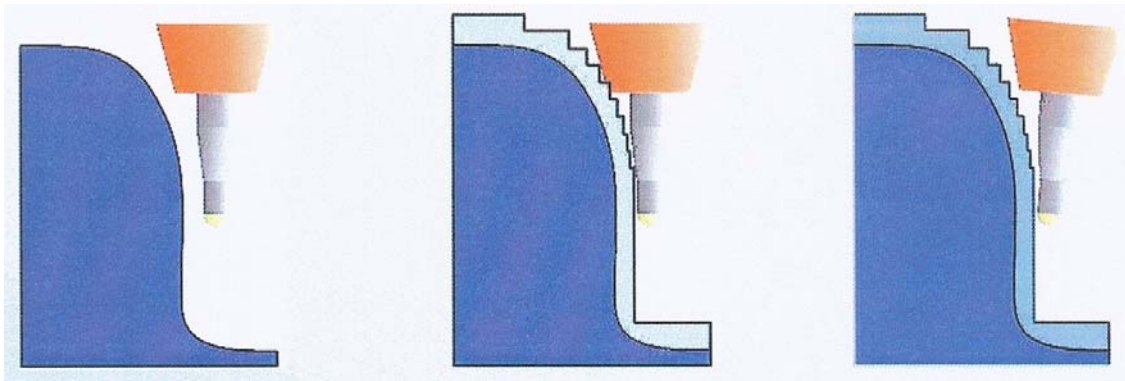


Fig. 1: Conversion from 3-axis machining to 5-axis machining in system NCspeed

These data NCspeed uses for simulation of machining process, defines new cut feeds that match better machining process. These cut feeds are then written into optimized NC data, which is executed on the machine. NCspeed is additionally optimizing height of passes above material a very important is the optimization of machining in the air.

NC Simul (spring Technologies SA) - this product allows checking of NC programs not only from the perspective of tool and workpiece, but from the complex perspective of production (machine – tool – workpiece) as it will be really realized. Its major advantage compared to another simulating products integrated into CAD/CAM systems is the possibility of creating a virtual machine, including all of the kinematic joints between its parts.

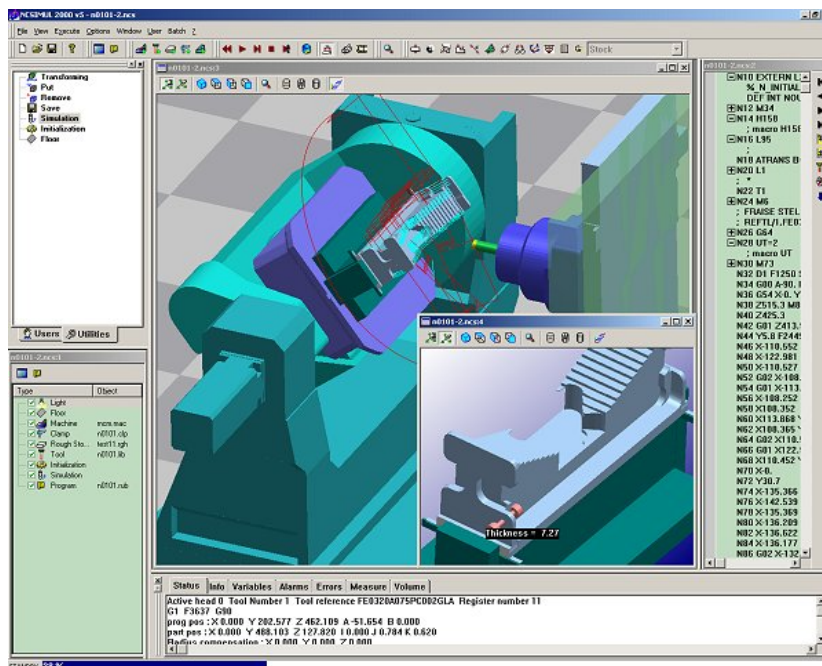


Fig. 2: Workspace in system NC Simul

Unlike other classic simulating devices included into CAD/CAM systems of lower and middle class NC Simul allows verification of control data in final form for concrete control system and not only their geometric image knows like CL – data. It is a possibility to reveal mistakes incurred for example by poor CAD/CAM system postprocessor. NC Simul supports two basic tasks technology and programmer: verification of machining, collision detection in the machine workspace and out of it, preparation of NC data and optimization of cutting process with aid of program tool Optitool.

PS-OptiFEED (Delcam) – CA system PowerMILL contains addition module PS-OptiFEED, which analyzes toolpaths generated with PowerMILL and automatically regulates cut feed with a view to reach constant speed in material removing. Next advantages of using this optimization tool consist in reduced tool wear and machinery, more accurate finishing a decreased need of machine operator. We can save up to 50% machining time with using this software and thereby markedly support productivity growing.

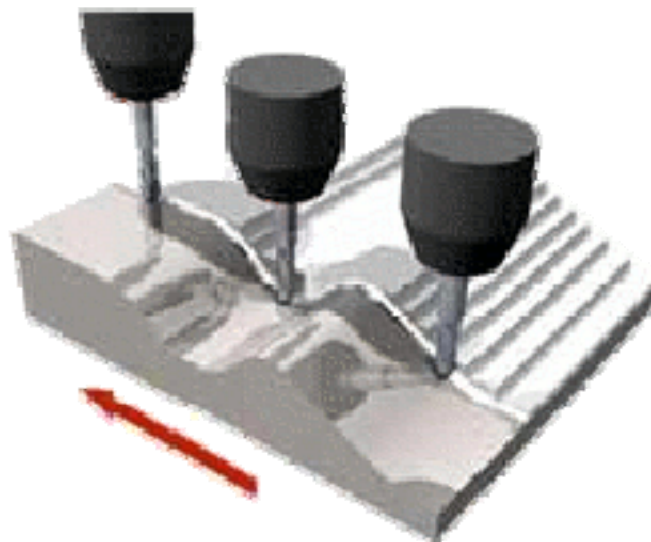


Fig. 3: *simulation of machining in system OptiFEED*

2.3 Optimization software implemented into CAM systems

This group of systems contains module for optimization of cutting conditions directly in CAM. One of these systems is VERICUT, which exists as variation of implemented optimization module of CAM system like VERICUT for Unigraphics (CGTech), VERICUT for Pro/ENGINEER (CGTech). Software VERICUT simulates NC machining for specification of toolpath mistakes and surplus moves. During NC data preparation it is able to

reduce mistakes that lead to damage of component, fixture, tool breakage, or machine crash and that all without testing on working machine. Into major functions belong simulation, verification and machining analysis, optimization of cutting conditions and simulation of working machines. OptiPath is a module optimizing NC data and increasing their speed and performance. Optipath sets cut speed of NC program for faster, effective and better machining process. It works on a simple principle – based on amount of material removal in every segment of cut. Software calculates and inserts modified cut feed to necessary places. In places with less material removal OptiPath increases cut feed and in places with higher material removal cut feed decreases. Without change in trajectory newest information are used in new path.

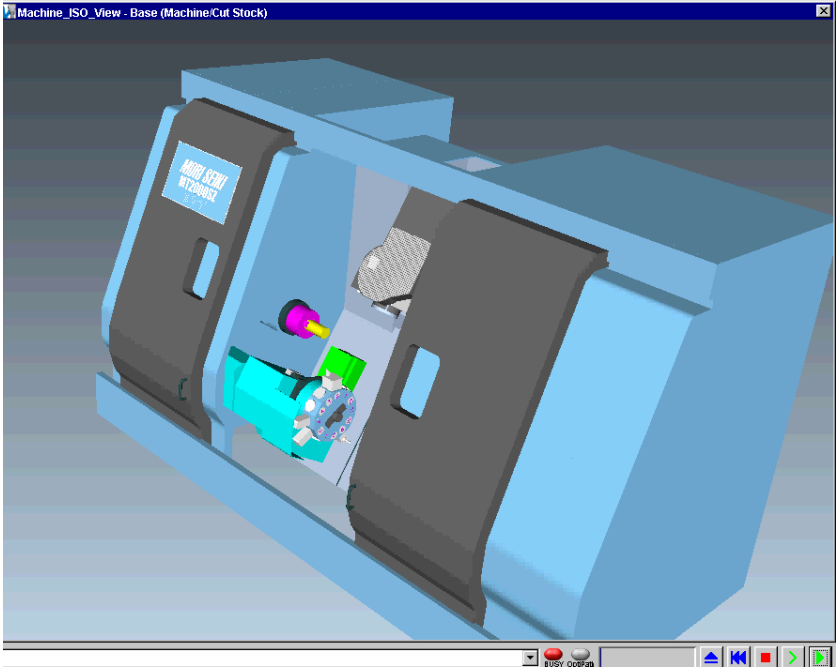


Fig. 4: 3D simulation of machining on CNC machine in system Vericut

Optipath loads toolpath NC file and divide the toolpath into several smaller segments. While it is necessary, it sets the best cut feed for designed cutting conditions according to amount of currently material removal. Then the software designs new toolpath, identical to previous, but the toolpath has modified cut feed. If users sets optimal cut feed for several before defined machining modes, OptiPath automatically combine them with factors like working machine capacity (engine performance, spindle type, rapid feed, coolant etc.), toughness of work clamping, tool type (material, shape, tooth amount, length, etc.), for setting optimal cut feed for every cut segment. OptiPath reduces machining time up to 30%, decreases production cost, machine and tool wear and increases surface quality.

3. CONCLUSION

In this article is theoretically optimization of technological process with use of optimizing modules in CAD/CAM systems approached. Optimization of NC technology rests in selection of one optimal variant from several possible. Variant theoretically solved in CAD/CAM systems with aid of NC module of CAD/CAM system and module for simulation and verification of NC data minimizes costs of their creation and verification and brings qualitative basis for optimizing and decision process. This all then goes towards serious decreasing of costs and work expenditure not only in technology, but to costs decreasing of NC data debugging too. Consequently it is able with optimized NC data to decrease direct costs of every part machined on NC machine. This will show in mechanical production effectiveness of every user of modern CAD/CAM system. Using one of these optimization systems we can achieve: decreasing of machine time, prevention from tool breakage, increasing tool lifetime, increasing of accuracy or quality of machined surface, restriction of surplus tool moves and prevention from CAM workplace mistakes. Production process optimization is a powerful tool for massive affection of productivity, part cost and thereby its implementation on the market. Because of that it is important to pay increased attention to this field and notice especially new trends in the field of CA systems, which can aid us to make our production process more effective.

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